What is claimed is:

1. An optical transmission system comprising:

an optical terminal;

an optical-fiber transmission line connected to the optical terminal; and

an optical repeater arranged along the optical-fiber transmission line;

the optical terminal includes,

an optical-signal power detection unit which detects power of optical signals transmitted from the optical terminal in each of a plurality of gain bands,

a tone-signal generation unit which generates a plurality of tone signals respectively corresponding to the plurality of gain bands, where each of the plurality of tone signals has a different frequency and a characteristic corresponding to the power of optical signals in one of the plurality of gain bands corresponding to the each of the plurality of tone signals, and

an optical transmission unit which transmits the plurality of tone signals together with optical signals through the optical-fiber transmission line;

the optical repeater includes,

an optical amplification unit which realizes optical amplification in each of the plurality of gain bands with a gain which is determined based on a

control signal,

a characteristic-signal generation unit which receives the plurality of tone signals, and generates a plurality of characteristic signals each representing the characteristic of one of the plurality of tone signals, and

a gain control unit which compares each of the plurality of characteristic signals with a reference signal, and generates the control signal corresponding to each of the plurality of gain bands so as to equalize the gain in the optical amplification in each of the plurality of gain bands.

2. The optical transmission system according to claim 1, wherein the optical amplification unit injects excitation light into the optical-fiber transmission line, which is used as an amplification medium in the optical amplification.

3. The optical transmission system according to claim 1, wherein the characteristic-signal generation unit comprises,

a photoelectric conversion unit which receives the plurality of tone signals, and generates an electric signal representing the plurality of tone signals,

a plurality of frequency filters which respectively extract the plurality of tone signals from

the electric signal, and

a smoothing unit which smoothes the plurality of tone signals extracted by the plurality of frequency filters so as to generate the plurality of characteristic signals.

4. The optical transmission system according to claim 1, wherein the characteristic of each of the plurality of tone signals is the frequency of the each of the plurality of tone signals or a modulation depth with which the each of the plurality of tone signals is modulated,

the tone-signal generation unit decreases the modulation depth of one of the plurality of tone signals or increases a difference between a predetermined frequency and the frequency of the one of the plurality of tone signals in order to increase the gain in the optical amplification in one of the plurality of gain bands corresponding to the one of the plurality of tone signals, and

the tone-signal generation unit increases the modulation depth of one of the plurality of tone signals or decreases a difference between the predetermined frequency and the frequency of the one of the plurality of tone signals in order to decrease the gain in the optical amplification in one of the plurality of gain bands corresponding to the one of the plurality of tone signals.

5. The optical transmission system according to claim 1, wherein the optical amplification unit includes more than two excitation light sources each of which emits excitation light having a different wavelength, and the optical transmission system further comprises an optical multiplexing unit which optically multiplexes the excitation light emitted by the more than two excitation light sources.

6. The optical transmission system according to claim 1, further comprising a driving control unit which activates and deactivates the optical amplification unit.

7. An optical transmission system comprising:

an optical terminal;

a plurality of optical-fiber transmission lines connected to the optical terminal; and

an optical repeater arranged along the plurality of optical-fiber transmission lines;

the optical terminal includes,

an optical-signal power detection unit which detects power of optical signals transmitted from the optical terminal in each of a plurality of gain bands through each of the plurality of optical-fiber transmission lines,

a tone-signal generation unit which

generates a plurality of tone signals respectively corresponding to the plurality of gain bands for each of the plurality of optical-fiber transmission lines, where each of the plurality of tone signals has a different frequency, and each of the plurality of tone signals for each of the plurality of optical-fiber transmission lines has a characteristic corresponding to the power of optical signals transmitted in one of a plurality of gain bands corresponding to the each of the plurality of tone signals in the each of the plurality of optical-fiber transmission lines, and

an optical transmission unit which transmits the plurality of tone signals together with optical signals through each of the plurality of optical-fiber transmission lines;

the optical repeater includes,

an optical amplification unit which realizes optical amplification in each of the plurality of gain bands with a gain which is determined based on a control signal,

a characteristic-signal generation unit which receives the plurality of tone signals from each of the plurality of optical-fiber transmission lines, and generates a plurality of characteristic signals each representing the characteristic of one of the plurality of tone signals received from each of the plurality of optical-fiber transmission lines,

an averaging unit which obtains for each of the plurality of gain bands an average of ones of the plurality of characteristic signals corresponding to both of the plurality of optical-fiber transmission lines and the each of the plurality of gain bands, and

a gain control unit which compares the average with a reference signal, and generates the control signal for each of the plurality of gain bands so as to equalize the gain in the optical amplification in each of the plurality of gain bands.

8. An optical terminal comprising:

an optical-signal power detection unit which detects power of optical signals transmitted from the optical terminal in each of a plurality of gain bands;

a tone-signal generation unit which generates a plurality of tone signals respectively corresponding to the plurality of gain bands, where each of the plurality of tone signals has a different frequency and a characteristic corresponding to the power of optical signals in one of the plurality of gain bands corresponding to the each of the plurality of tone signals; and

an optical transmission unit which transmits the plurality of tone signals together with optical signals through the optical-fiber transmission line.

9. The optical terminal according to claim 8, wherein the characteristic of each of the plurality of tone signals is the frequency of the each of the plurality of tone signals or a modulation depth with which the each of the plurality of tone signals is modulated,

the tone-signal generation unit decreases the modulation depth of one of the plurality of tone signals or increases a difference between a predetermined frequency and the frequency of the one of the plurality of tone signals in order to increase a gain in optical amplification in one of the plurality of gain bands corresponding to the one of the plurality of tone signals, and

the tone-signal generation unit increases the modulation depth of one of the plurality of tone signals or decreases a difference between the predetermined frequency and the frequency of the one of the plurality of tone signals in order to decrease a gain in optical amplification in one of the plurality of gain bands corresponding to the one of the plurality of tone signals.

10. An optical repeater comprising:

an optical amplification unit which realizes optical amplification in each of a plurality of gain bands with a gain which is determined based on a control signal;

a characteristic-signal generation unit which receives a plurality of tone signals, and generates a plurality of characteristic signals each representing a characteristic of one of the plurality of tone signals; and

a gain control unit which compares each of the plurality of characteristic signals with a reference signal, and generates the control signal corresponding to each of the plurality of gain bands so as to equalize the gain in the optical amplification in each of the plurality of gain bands.

11. The optical repeater according to claim 10, wherein the optical amplification unit injects excitation light into an optical-fiber transmission line, which is used as an amplification medium in the optical amplification.

12. The optical repeater according to claim 10, wherein the characteristic-signal generation unit comprises,

a photoelectric conversion unit which receives the plurality of tone signals, and generates an electric signal representing the plurality of tone signals,

a plurality of frequency filters which respectively extract the plurality of tone signals from the electric signal, and

a smoothing unit which smoothes the plurality of tone signals extracted by the plurality of frequency filters so as to generate the plurality of characteristic signals.

13. The optical repeater according to claim 10, wherein the optical amplification unit includes more than two excitation light sources each of which emits excitation light having a different wavelength, and the optical repeater further comprises an optical multiplexing unit which optically multiplexes the excitation light emitted by the more than two excitation light sources.

14. The optical repeater according to claim 10, further comprising a driving control unit which activates and deactivates the optical amplification unit.

15. An optical repeater being able to be connected to a plurality of optical-fiber transmission lines and comprising:

an optical amplification unit which realizes optical amplification in each of a plurality of gain bands with a gain which is determined based on a control signal,

a characteristic-signal generation unit which receives a plurality of tone signals from each of the plurality of optical-fiber transmission lines, and

generates a plurality of characteristic signals each representing a characteristic of one of the plurality of tone signals received from each of the plurality of optical-fiber transmission lines,

an averaging unit which obtains for each of the plurality of gain bands an average of ones of the plurality of characteristic signals corresponding to both of the plurality of optical-fiber transmission lines and the each of the plurality of gain bands, and

a gain control unit which compares the average with a reference signal, and generates the control signal for each of the plurality of gain bands so as to equalize the gain in the optical amplification in each of the plurality of gain bands.

16. An optical transmission system comprising:

an optical terminal;

an optical-fiber transmission line connected to the optical terminal; and

an optical repeater arranged along the optical-fiber transmission line;

the optical terminal includes,

an optical-signal power detection unit which detects power of optical signals transmitted from the optical terminal in each of a plurality of gain bands,

a tone-signal generation unit which generates a plurality of tone signals respectively

corresponding to the plurality of gain bands, where each of the plurality of tone signals has a different frequency and a characteristic corresponding to the power of optical signals in one of the plurality of gain bands corresponding to the each of the plurality of tone signals, and

an optical transmission unit which transmits the plurality of tone signals together with optical signals through the optical-fiber transmission line;

the optical repeater includes,

a first optical amplification unit which realizes optical amplification in a first one of the plurality of gain bands with constant light emission,

a second optical amplification unit which realizes optical amplification in each of the plurality of gain bands except for the first one of the plurality of gain bands with a gain which is determined based on a control signal,

a characteristic-signal generation unit which receives the plurality of tone signals, and generates a plurality of characteristic signals each representing the characteristic of one of the plurality of tone signals, and

a gain control unit which compares each of the plurality of characteristic signals corresponding to the plurality of gain bands except for the first one of

the plurality of gain bands, with a reference signal, and generates the control signal corresponding to each of the plurality of gain bands except for the first one of the plurality of gain bands so as to equalize the gain in the optical amplification in each of the plurality of gain bands, where the reference signal is one of the plurality of characteristic signals corresponding to the first one of the plurality of gain bands.

17. The optical transmission system according to claim 16, wherein the first optical amplification unit and the second optical amplification unit inject excitation light into the optical-fiber transmission line, which is used as an amplification medium in the optical amplification.

18. The optical transmission system according to claim 16, wherein the characteristic-signal generation unit comprises,

a photoelectric conversion unit which receives the plurality of tone signals, and generates an electric signal representing the plurality of tone signals,

a plurality of frequency filters which respectively extract the plurality of tone signals from the electric signal, and

a smoothing unit which smoothes the plurality of tone signals extracted by the plurality of

frequency filters so as to generate the plurality of characteristic signals.

19. The optical transmission system according to claim 16, wherein the characteristic of each of the plurality of tone signals is the frequency of the each of the plurality of tone signals or a modulation depth with which the each of the plurality of tone signals is modulated,

the tone-signal generation unit decreases the modulation depth of one of the plurality of tone signals or increases a difference between a predetermined frequency and the frequency of the one of the plurality of tone signals in order to increase the gain in the optical amplification in one of the plurality of gain bands corresponding to the one of the plurality of tone signals, and

the tone-signal generation unit increases the modulation depth of one of the plurality of tone signals or decreases a difference between the predetermined frequency and the frequency of the one of the plurality of tone signals in order to decrease the gain in the optical amplification in one of the plurality of gain bands corresponding to the one of the plurality of tone signals.

20. The optical transmission system according to claim 16, wherein the first optical amplification unit and

the second optical amplification unit include more than two excitation light sources each of which emits excitation light having a different wavelength, and the optical transmission system further comprises an optical multiplexing unit which optically multiplexes the excitation light emitted by the more than two excitation light sources.

21. The optical transmission system according to claim 16, further comprising a driving control unit which activates and deactivates the second optical amplification unit.

22. An optical transmission system comprising:

an optical terminal;

a plurality of optical-fiber transmission lines connected to the optical terminal; and

an optical repeater arranged along the plurality of optical-fiber transmission lines;

the optical terminal includes,

an optical-signal power detection unit which detects power of optical signals transmitted from the optical terminal in each of a plurality of gain bands through each of the plurality of optical-fiber transmission lines,

a tone-signal generation unit which generates a plurality of tone signals respectively

corresponding to the plurality of gain bands for each of the plurality of optical-fiber transmission lines, where each of the plurality of tone signals has a different frequency, and each of the plurality of tone signals for each of the plurality of optical-fiber transmission lines has a characteristic corresponding to the power of optical signals transmitted in one of a plurality of gain bands corresponding to the each of the plurality of tone signals in the each of the plurality of optical-fiber transmission lines, and

an optical transmission unit which transmits the plurality of tone signals together with optical signals through each of the plurality of optical-fiber transmission lines;

the optical repeater includes,

a first optical amplification unit which realizes optical amplification in a first one of the plurality of gain bands in each of the plurality of optical-fiber transmission lines with constant light emission,

a second optical amplification unit which realizes optical amplification in each of the plurality of gain bands except for the first one of the plurality of gain bands in each of the plurality of optical-fiber transmission lines, with a gain which is determined based on a control signal,

a characteristic-signal generation unit

which receives the plurality of tone signals from each of the plurality of optical-fiber transmission lines, and generates a plurality of characteristic signals each representing the characteristic of one of the plurality of tone signals received from each of the plurality of optical-fiber transmission lines,

an averaging unit which obtains for each of the plurality of gain bands an average of ones of the plurality of characteristic signals corresponding to both of the plurality of optical-fiber transmission lines and the each of the plurality of gain bands, and

a gain control unit which compares the average obtained for each of the plurality of gain bands except for the first one of the plurality of gain bands, with a reference signal, and generates the control signal for each of the plurality of gain bands except for the first one of the plurality of gain bands so as to equalize the gain in the optical amplification in each of the plurality of gain bands, where the reference signal is the average obtained for the first one of the plurality of gain bands.

23. An optical terminal comprising:

an optical-signal power detection unit which detects power of optical signals transmitted from the optical terminal in each of a plurality of gain bands;

a tone-signal generation unit which

generates a plurality of tone signals respectively corresponding to the plurality of gain bands, where each of the plurality of tone signals has a different frequency and a characteristic corresponding to the power of optical signals in one of the plurality of gain bands corresponding to the each of the plurality of tone signals; and

an optical transmission unit which transmits the plurality of tone signals together with optical signals through the optical-fiber transmission line.

24. The optical terminal according to claim 23, wherein the characteristic of each of the plurality of tone signals is the frequency of the each of the plurality of tone signals or a modulation depth with which the each of the plurality of tone signals is modulated,

the tone-signal generation unit decreases the modulation depth of one of the plurality of tone signals or increases a difference between a predetermined frequency and the frequency of the one of the plurality of tone signals in order to increase a gain in optical amplification in one of the plurality of gain bands corresponding to the one of the plurality of tone signals, and

the tone-signal generation unit increases the modulation depth of one of the plurality of tone signals

or decreases a difference between the predetermined frequency and the frequency of the one of the plurality of tone signals in order to decrease a gain in optical amplification in one of the plurality of gain bands corresponding to the one of the plurality of tone signals.

25. An optical repeater comprising:

a first optical amplification unit which realizes optical amplification in a first one of a plurality of gain bands with constant light emission,

a second optical amplification unit which realizes optical amplification in each of the plurality of gain bands except for the first one of the plurality of gain bands with a gain which is determined based on a control signal,

a characteristic-signal generation unit which receives a plurality of tone signals, and generates a plurality of characteristic signals each representing a characteristic of one of the plurality of tone signals, and

a gain control unit which compares each of the plurality of characteristic signals corresponding to the plurality of gain bands except for the first one of the plurality of gain bands, with a reference signal, and generates the control signal corresponding to each of the plurality of gain bands except for the first one of the plurality of gain bands so as to equalize the gain in the

optical amplification in each of the plurality of gain bands, where the reference signal is one of the plurality of characteristic signals corresponding to the first one of the plurality of gain bands.

26. The optical repeater according to claim 25, wherein the first optical amplification unit and the second optical amplification unit inject excitation light into the optical-fiber transmission line, which is used as an amplification medium in the optical amplification.

27. The optical repeater according to claim 25, wherein the characteristic-signal generation unit comprises,

a photoelectric conversion unit which receives the plurality of tone signals, and generates an electric signal representing the plurality of tone signals,

a plurality of frequency filters which respectively extract the plurality of tone signals from the electric signal, and

a smoothing unit which smoothes the plurality of tone signals extracted by the plurality of frequency filters so as to generate the plurality of characteristic signals.

28. The optical repeater according to claim 25, wherein the first optical amplification unit and the

second optical amplification unit include more than two excitation light sources each of which emits excitation light having a different wavelength, and the optical repeater further comprises an optical multiplexing unit which optically multiplexes the excitation light emitted by the more than two excitation light sources.

29. The optical repeater according to claim 25, further comprising a driving control unit which activates and deactivates the second optical amplification unit.

30. An optical repeater being able to be connected to a plurality of optical-fiber transmission lines and comprising:

a first optical amplification unit which realizes optical amplification in a first one of a plurality of gain bands in each of the plurality of optical-fiber transmission lines with constant light emission,

a second optical amplification unit which realizes optical amplification in each of the plurality of gain bands except for the first one of the plurality of gain bands in each of the plurality of optical-fiber transmission lines, with a gain which is determined based on a control signal,

a characteristic-signal generation unit which receives a plurality of tone signals from each of

the plurality of optical-fiber transmission lines, and generates a plurality of characteristic signals each representing a characteristic of one of the plurality of tone signals received from each of the plurality of optical-fiber transmission lines,

an averaging unit which obtains for each of the plurality of gain bands an average of ones of the plurality of characteristic signals corresponding to both of the plurality of optical-fiber transmission lines and the each of the plurality of gain bands, and

a gain control unit which compares the average obtained for each of the plurality of gain bands except for the first one of the plurality of gain bands, with a reference signal, and generates the control signal for each of the plurality of gain bands except for the first one of the plurality of gain bands so as to equalize the gain in the optical amplification in each of the plurality of gain bands, where the reference signal is the average obtained for the first one of the plurality of gain bands.